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ABSTRACT

Past research based primarily on cross-sectional data, has suggested a Guttman scale of substance use onset where marijuana use is preceded by alcohol use, and where sometimes tobacco is placed between alcohol and marijuana. Prospective longitudinal data is needed to determine whether the stages form a temporal sequence. A new statistical methodology, Longitudinal Guttman Scaling, was used to investigate the hypothesis that there exist temporally ordered stages of substance use. Data were obtained from four waves of panel data from the High School Anti-Smoking Project, which took place between 1981 and 1983 in Los Angeles, California. Subjects were high school sophomores at the start of the study and seniors at the end. Results indicated that there are at least two stage sequences of substance use onset: Tobacco Use Onset, composed primarily of tobacco use items; and Multiple Heavy Use, consisting of alcohol, tobacco, and marijuana items. Both sequences begin with a general experimentation phase where alcohol, tobacco, and marijuana are tried before heavier use of any substance is adopted. This replicates the findings of previous studies, but suggests that they may hold only for initial experimentation. Somewhat weaker evidence was found for a Moderate Alcohol Use sequence, beginning with beer, wine, and liquor followed by moderate alcohol use. (Author/NB)

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Stage Sequences of Adolescent Substance Use: A Prospective Longitudinal Approach

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Stage Sequences of Adolescent Substance Use:

A Prospective Longitudinal Approach

ABSTRACT

Past research has suggested a Guttman scale of substance use onset where marijuana use is preceeded by alcohol use, and where sometimes tobacco is placed between alcohol and marijuana. However, these conclusions have been based primarily on cross-sectional data. Because the essential question is whether the stages form a temporal sequence, prospective longitudinal data provide the most direct means of addressing the issue. The present paper uses a new statistical methodology called Longitudinal Guttman Scaling in order to investigate the hypothesis that there exist temporally ordered stages of substance use. Data are four waves of panel data from the High School Anti-Smoking Project, which took place between 1981 and 1983 in Los Angeles. Subjects were sophomores at the start of the study and seniors at the end. Results indicate that there are at least two stage sequences of substance use onset. The two sequences are Tobacco Use Onset, composed primarily of tobacco use items, and Multiple Heavy Use, consisting of alcohol, tobacco, and marijuana items. Both of these sequences begin with a general experimentation phase where alcohol, tobacco, and marijuana are tried before heavier use of any substance is adopted. This replicates the findings of previous studies, but suggests that they may hold only for initial experimentation. Somewhat weaker evidence was found for a Moderate Alcohol Use sequence, beginning with beer, wine, and liquor followed by moderate alcohol use. Overall consistency of the sequences was lower in this study than has been shown in past research, indicating that the high level of consistency found in past studies may be at least partly a function of response bias.

Stage Sequences of Adolescent Substance Use:
A Prospective Longitudinal Approach

The idea of a developmental sequence of stages making up a substance use onset process has existed since at least 1940, when the mayor of New York asked the New York Academy of Medicine to investigate the idea that marijuana was a precursor to heroin use (Cohen, 1972). The longevity of the idea is due to its appeal on a number of dimensions. First, it seems intuitively reasonable that substance use ought to arrange itself along a definable continuum from less serious to more serious activities. Second, the stage-sequence notion provides a framework that has the potential to be quite useful in prevention research and applications. If stages in the onset process could be identified and measured, and an assessment made of subject stage membership, this would be a valuable tool. For example, prevention efforts could be directed toward the needs of individual program recipients according to their respective places in the continuum, rather than according to age or grade in school as is typically done.

For these reasons much theoretical and empirical work has been devoted to conceptualizations of stage sequences making up a substance use onset process. Usually the theory is one of a set of cumulative stages, which means that in cross-sectional data the stages form a Guttman scale. Support for the idea of a Guttman scale of substance use in cross-sectional data has been found by a number of researchers (Sinnett, Wampler, & Harvey, 1972; Single, Kandel, & Faust, 1975; Hamburg, Kraemer, & Jahnke, 1975; Huba, Wingard, & Bentler, 1981; Donovan & Jessor, 1983). In general, the findings of these studies show that those who report the use of hard drugs report the use of marijuana and alcohol as well, and that those who report the use of marijuana report the use of alcohol. These

findings are not inconsistent with the idea that there is a sequence beginning with alcohol, which is followed by marijuana, which is in turn followed by harder drugs.

However, when we think of a stage sequence of drug use, we are thinking less about whether those reporting marijuana use also report alcohol use than about whether those who have used marijuana used alcohol first. That is, what we really want to know is whether there is a developmental sequence of drug use through which subjects progress over time, or what Donovan and Jessor (1983) called "a dimension of temporally-related involvement."

The researcher who has come closest to answering the question of whether there is a sequence of drug use involvement is Kandel (1975; Kandel & Faust, 1975; Yamaguchi & Kandel, 1984). In two related two-panel prospective longitudinal studies, Kandel and Faust (1975) demonstrated the existence of a four-stage progession, beginning with beer or wine, then cigarettes or hard liquor, then marijuana, then other illicit drugs. In a subsequent study using retrospective data, Yamaguchi and Kandel (1984) demonstrated the existence of recalled drug use sequences quite similar to the sequences found by Kandel and Faust (1975). The recalled drug use sequences for males were the following: alcohol preceded marijuana, alcohol and marijuana preceded other illicit drugs, and alcohol, marijuana, and cigarettes preceded prescribed psychoactive drugs. For women, the pattern was much the same, except that cigarettes were an alternate precursor to marijuana use and preceded all other substance use. In general, these results are consistent with the findings of the cross-sectional studies.

The research discussed above leaves several questions unanswered. The first question concerns where degree of involvement with a substance fits in a

substance use sequence. Most studies have operationalized use at one level only, usually asking subjects either whether they have ever tried a substance or whether they currently use a substance. Such data cannot tell us, for example, whether adolescents become regular alcohol users before they try marijuana, or whether adolescents tend to try a variety of substances before they adopt regular use of any one substance. An exception is Donovan and Jessor (1983), who included both a "normal" alcohol use stage and a "problem drinking" stage in their Guttman scaling of substance use. They found that the "problem drinking" stage fit between "used marijuana" and "used pills." Thus, although alcohol was generally tried before marijuana, heavier use of alcohol came after marijuana was tried.

Second, no study has yet filled the need identified by Yamaguchi and Kandel (1984) for "a follow-up of young people over several years with a detailed monitoring of their drug behavior past the period of risk for initiation into the relevant drugs." Although Kandel and Faust (1975) used a prospective longitudinal design, each of their two studies took place over no more than nine months. The need for longer-term research is what motivated the Yamaguchi and Kandel (1984) study, which is the first detailed look at substance use sequences in a cohort over a period of several years.

However, the results of the Yamaguchi and Kandel (1984) study must be looked upon with caution because they are based on retrospective data. Collins, Graham, Hansen, and Johnson (1985) compared retrospective accounts of tobacco, marijuana, and alcohol use with the subjects' actual reports of use and found several souces of bias in recall. There was a tendency for subjects not to recall having tried a substance; retrospective accounts of use habits ("How often did you use...") tended to be underestimates of reported use when tobacco and alcohol were

recalled, but under some circumstances were overestimates of reported marijuana use; current substance use systematically biased recall of past use, particularly recall of alcohol use; and as the time between the retrospective account and the concurrent report increased, agreement decreased while the bias due to current use remained about the same.

The findings of the Collins et al. (1985) study are consistent with the idea that people impose their own cognitive schemata on their memories of past substance use. In particular, the finding of bias in recall due to current use suggests that people remember past use in such a way as to make it more consistent with the present. This suggestion affects the interpretation of studies based on retrospective data. For example, in Yamaguchi and Kandel's (1984) data collection procedure subjects are asked to recall a series of behaviors over the past several years. Under these circumstances there may be a tendency to give consistent responses or actually to recall the behavior as having been more consistent than it was. This means that the obtained recalled progressions of substance use may be more consistent than was actually the case. In addition, most lay people are aware of the idea that marijuana "leads to" harder drugs. This awareness may affect their recall of the order in which they adopted the use of various substances.

Prospective Longitudinal Data and Guttman Scaling

The above discussion has shown that the Guttman scale is a useful model of the development of substance use behavior, and that prospective longitudinal research is the preferred method of investigating whether various substances form a developmental sequence over time. Although taking a longitudinal prospective approach to the study of stage sequences in adolescent drug use is clearly interesting, until recently it was difficult to apply Guttman scaling methodology

in this context. The researcher wishing to incorporate Guttman scaling in a prospective longitudinal study had really only one alternative, that of applying Guttman scaling to each wave of data separately and perhaps comparing adjacent waves (Kandel & Faust, 1975). This falls short of the mark, which is assessing the degree to which subjects procede through a set of stages in a sequential and cumulative fashion. However, a new scaling methodology has been developed that allows exactly such an assessment. The new scaling model is called the longitudinal Guttman simplex, or LGS (Collins & Cliff, 1985; Collins, Dent, & Cliff, 1985; Collins, Cliff, & Dent, 1986). The LGS is a scaling model expressly for prospective longitudinal data. The LGS methodology provides a means for judging the fit of this scaling model to empirical data.

The LGS model and methodology offer a number of benefits. A LGS is a set of stages through which subjects progress in a sequential and cumulative fashion over time. Thus, the first benefit is that the LGS methodology provides a way of assessing the degree to which a set of stages is gone through by subjects in a sequential and cumulative fashion over time, a question clearly at the heart of research in the area of stage theories of substance use acquisition. Second, the LGS model does not limit the researcher to the comparison of two waves of measurement in a longitudinal study; instead, the model can include any number of occasions of measurement simultaneously. Third, most methodologies handle missing data by means of listwise deletion; that is, a subject who has incomplete data must be dropped from the analysis. In contrast, the LGS methodology can make use of partial data from subjects. This means, for example, that a subject missing from the second wave of a three-wave panel study can be included in the analysis. Since it has been demonstrated many times that drop-outs in a study tend to be different from those who are present througout the study (Hansen,

Collins, Malotte, Johnson, & Fielding, 1985; Biglan & Ary, 1985) the ability to include partial data from drop-outs clearly increases the generalizability of a study's findings. Finally, the LGS methodology includes an exploratory procedure. This procedure identifies subsets of longitudinal items forming consistent cumulative sequences.

The Present Paper

The purpose of the present paper is to use LGS methodology (1) to investigate the existence of stage sequences of adolescent drug use behavior in prospective longitudinal data collected over a three-year period, and (2) to determine where various levels of use fit in the stage sequence. First the consistency of a sequence made up of all available substance use stages in the data set will be examined. Second, the set of available stages will be examined by means of an exploratory procedure in order to identify subsets of stages forming consistent sequences, that is, forming longitudinal Guttman scales. The degree to which the obtained longitudinal scales cross-validate and are robust across sex will be examined.

METHODS

The LGS Model

The Guttman simplex is a model specifying a joint order of persons and items. If a set of substances forms a Guttman simplex, this means that the substances can be ordered according to the frequency of "yes", "use", etc. responses and simultaneously the persons are ordered according to the extent of their substance use involvement. The LGS model is an extention of the Guttman simplex model so that besides persons and items it incorporates times as well. An LGS is a joint order of items and times consistent across persons. If a set of substances forms a LGS, this means that for each subject (1) the substances

are ordered the same; (2) the times are ordered the same; and (3) the substances and times form a Guttman scale. This is another way of saying that the LGS is a model of sequential cumulative development. By cumulative it is meant that as new stages are reached membership in previous stages is retained. By sequential it is meant that all subjects procede through the stages in the same sequence.

Below is a simple hypothetical example of a set of substance use stages forming a perfect LGS:

	Tried Alcohol	Tried Marijuana	Tried Pills
Person 1			
Time 1	Yes	No	No
Time 2	Yes	Yes	No
Time 3	Yes	Yes	No
Person 2			
Time 1	No	No	No
Time 2	Yes	No	No
Time 3	Yes	Yes	Yes

This hypothetical example illustrates a number of features of the LGS model. First, for both persons the stages are ordered the same: first alcohol, then marijuana, then pills. Second, there is a temporal order for both persons: no more use takes place at Time 2 than at Time 3, and no more use takes place at Time 1 than at Time 2. Third, there is a joint stages-times order for each person. That is, each subject's responses can be arranged so that the stages are in order of their place along the substance use continuum, and simultaneously the

times are arranged in order of overall instances of use. In other words, there is a Guttman scale of stages and times for each person, and this Guttman scale is consistent across persons. More conceptually, the above hypothetical example shows how the LGS is a model of sequential cumulative development. Development is sequential because each person moves through the stages in the same order; it is cumulative because a person who has reached the "tried marijuana" stage retains membership in the "tried alcohol" stage.

Two additional features of the LGS model follow from its definition and are illustrated in the example. First, the model does not require that persons move through the stages at a constant rate, nor that the rate of stage acquisition be the same across persons. The hypothetical example shows that Person 2 moved quite quickly through the stages between Times 2 and 3. In fact, at Times 1 and 2 Person 1 showed more experience with substances than Person 2, but this order was reversed at Time 3 due to Person 2's rapid development. Second, the LGS model does not require that all subjects complete the stage sequence. In the hypothetical example Person 1 never reaches the "tried pills" stage.

LGS procedures

Collins and collegues (Collins et al., 1985; Collins & Dent, 1986) have developed a set of LGS procedures. The first procedure, LGSINDEX (Collins & Dent, 1986), computes CL (Collins et al., 1985), a consistency index for longitudinal Guttman scales. Consistency indices, like Cronbach's Alpha (Cronbach, 1951) and Guttman's Coefficient of Reproducibility (Guttman, 1950), are quite common in scaling methodology. A consistency index assesses the degree to which a set of empirical data is consistent with a given scaling model. If the index is high, then the LGS model is a good description of the data; if the index is low, then the LGS model is not a good description of the data. CL is a

type of quality index (cf. Cliff, 1977), that is, it is adjusted for the effects of item marginals on scale consistency. This makes CL very sensitive to true differences in scale consistency. It is important to take note of the effect that the adjustment for chance levels of consistency has on the metric of the index. Given comparable degrees of consistency, CL tends to be lower than other indices. A CL of .3 or above represents a moderately consistent scale; a CL above about .5 is a very consistent scale (Collins et al., 1985). In a perfect LGS CL takes on a value of one.

The second procedure is LGSCLUS (Collins et al., 1986). This is an exploratory procedure for finding longitudinal Guttman scales within existing longitudinal data bases. LGSCLUS uses CL as a between-items distance measure. From this starting point the procedure makes use of an agglomerative, non-hierarchical clustering algorithm to identify subsets of items forming consistent longitudinal Guttman scales. Space limitations preclude a complete introduction to this procedure; for more information refer to Cliff, McCormick, Zatkin, Cudeck, and Collins (1986) and Collins et al. (1986).

Sample

The subjects used in the present study were drawn from the High School Anti-Smoking Project (HASP), which took place in nine high schools in the Los Angeles Unified School District (Johnson, Hansen, Collins, & Graham, 1986). The schools were racially and ethnically heterogeneous with approximately 40% White, 30% Hispanic, 20% Black, and 10% Asian; however, information on individual subject ethnicity is not available.

Data collection took place at four occasions: Winter 1981, Spring 1981, Spring 1982, and Spring 1983. Subjects were high school sophomores at the beginning of the study and seniors at the end. All together, 3574 students were

present at the first occasion of measurement and at least one subsequent occasion. However, program size limitations prohibited analysis of such a large sample. Therefore, from this pool of subjects two samples were drawn for analysis in the present paper: a criterion sample of 366 subjects, and a cross-validation sample of 342 subjects.

Both samples were drawn randomly, stratifying for sex in order to assure approximately equal numbers of males and females in each sample, subject to the following three eligibility criteria. First, subjects had to be present at the first wave of data collection and at least one subsequent wave. This was done to ensure that all subjects contributed longitudinal data. In the criterion sample 37 percent were present at all four occasions of measurement and 37 percent were present at three waves only; in the cross-validation sample 32 percent were present at all four occasions of measurement and 36 percent were present at three waves only. Second, subjects with logically inconsistent responses, that is, subjects who said they had tried a substance and then at a later time said they had not tried it, were not sampled. Third, subjects who showed no increase in the use of any substance at any time during the three-year study were not sampled. Because we were interested in the development of substance use behavior over time, it seemed reasonable to confine the sample to subjects undergoing at least minimal development. Given the age of the sample and the substances involved, this is not a very severe restriction.

Measures

Like all Guttman scaling procedures, the LGS procedure requires that variables be dichotomous, that is, yes/no, 0/1, etc. Many of the items on the HASP questionnaire were already in this format. Those that were not in this format were dichotomized by collapsing response categories. In several cases

items were dichotomized at more than one point, in order to reflect various levels of use. For example, the question "How often do you drink alcoholic beverages?" had the following response categories: I never drink alcohol; Less than once a month; Once a month or more but less than once a week; About once a week; More than once a week but not every day; Almost every day. Two dichotomous items were made from this question: Light Alcohol Use, which took on a value of one if a subject reported any alcohol use and a zero otherwise; and Heavier Alcohol Use, which took on a value of one if the subject reported using alcohol about once a week or more and a value of zero otherwise. Dichotomizing items at several points allowed the examination of where various levels of use fell in the substance use continuum.

Table 1 lists the questionnaire items used in the present study. The name of each drug use stage is in capital letters next to the item. Thus, if a subject responded "yes" to the question, "Have you ever tried wine?" the subject is considered to have reached the Tried Wine stage; if a subject responded "Almost every day" to the question "How often do you drink alcoholic beverages?" the subject is considered to have reached the Heavier Alcohol Use stage. Thus, 15 drug use stages were defined.

Insert Table 1 about Here

RESULTS

Data analysis in the present study began by applying LGSINDEX to all 15 substance use stages, in order to see whether the fifteen drug use stages form a consistent longitudinal Guttman scale. The resulting CL values were .28 for the

criterion sample and .25 for the cross-validation sample. This suggests that the 15 drug use stages form at best only a marginally consistent LGS.

Next the exploratory procedure LGSCLUS was applied to the criterion sample. The procedure indicated that three overlapping longitudinal Guttman scales were present within the larger set of 15 stages. These scales are shown in Table 2, 3, and 4, with the stages listed in order of precedence; that is, in Scale 1 Tried Beer is the first stage and Heavier Tobacco Use is the last. As in cross-sectional Guttman scaling, precedence is determined by examination of proportions of subjects in each stage. These proportions appear in Table 2-4. Because such proportions can be misleading when based on partial data, the proportions in these tables are based on the subjects who were present at all four occasions of measurement. The ordering of the stages is the same when the proportions are based on all 366 subjects.

Insert Tables 2, 3, and 4 about Here

Interestingly, all three scales begin with the same three items: Tried Beer, Tried Wine, and Tried Liquor. In addition, for Scales 1 and 2 the next two items are the same: Tried Tobacco and Tried Marijuana. However, after this point the scales are quite different. Scale 1 is a Tobacco Use Onset scale, suggesting a pattern consisting of a period of trying various substances followed by gradual adaptation of fairly regular smoking. Scale 2 is a Multiple Heavy Use scale, beginning with a pattern of experimentation followed by adaptation of relatively heavy use of all three substances. Although Light Marijuana Use is a stage in this sequence, Light Tobacco Use and Light Alcohol Use are not. Scale 3 has been

labelled Moderate Alcohol Use. This is a progession involving alcohol use only, and culminating in Light Alcohol Use.

Table 5 shows CL values for all three scales. CL was computed for both the criterion sample and the cross-validation sample, and separately for males and females within each sample. The Tobacco Use Onset scale is the most consistent of the three scales, cross-validates well, and is robust across sex in both the criterion and cross-validation samples. The Multiple Heavy Use scale is less consistent but still moderately consistent, and also cross-validates well. However, this scale seems to be considerably more consistent for boys than for girls, an effect that holds across both samples. Finally, the Normal Alcohol Use scale is the least consistent of the three. This scale is moderately consistent in the criterion sample, but unacceptable in the cross-validation sample. This scale also is less consistent for girls than for boys in the criterion sample.

Insert Table 5 about Here

The proportion of subjects who have tried wine and the proportion who have tried beer are quite similar at all four waves of measurement. Moreover, there does not seem to be a consistent ordering of first beer, then wine. Therefore, it seems that a more parsimonious approach would be to collapse Tried Beer and Tried Wine into one Tried Beer or Wine category. This was done and CL was recomputed for both the criterion and cross-validation samples. CL increased slightly in the Tobacco Use Onset and Moderate Alcohol Use scales, and stayed about the same in the Multiple Heavy Use scale.

DISCUSSION

When examined all together, the 15 drug use stages defined in the present study form at best a marginally consistent stage sequence over time. However, within these 15 stages there are three overlapping subsets of stages that form consistent longitudinal Guttman scales. The three scales are Tobacco Use Onset, Multiple Heavy Use, and Normal Alcohol Use.

The results of the present study are in partial agreement with past findings, including Kandel's, in that there is evidence that the substances are tried in the following order: first alcohol, then tobacco, then marijuana. However, the failure of the 15 items to form a consistent longitudinal scale suggests that the familiar stage sequences are not applicable beyond the initial trying of each drug.

The present study extends past findings in a number of ways. First, by means of a new statistical methodology called longitudinal Guttman scaling, the existence of at least two separate stage sequences was demonstrated. One stage sequence was found involving primarily tobacco use, and one was found involving multiple substance use. Additional weaker evidence was found for a third stage sequence involving only alcohol. Second, in both the Tobacco Use Onset and Multiple Heavy Use sequences subjects first progressed through a stage of trying <u>all</u> substances before moving into more frequent use of any substance. This suggests the existence of an overall substance experimentation phase before higher levels of use are adopted. Within this phase, substances are tried in the order found by Kandel and others, with tobacco a part of the experimentation. Beyond this phase, subjects may move into tobacco use, multiple substance use, or both. There is weaker evidence for the existence of another stage sequence where

the experimentation phase consists only of beer, wine, and liquor, after which there may be movement into moderate use of alcohol.

According to the present results, the last three stages in the Multiple Heavy Use sequence are heavier marijuana use, heavier alcohol use, and heavier tobacco use, in that order. However, the order of extremity of these stages is partly a function of where the items were dichotomized. In addition, the overall proportion of persons in each of these three stages is very close, and in some cases the order among them changes slightly from one occasion to another. This suggests that these three stages are best thought of as one "multiple heavy use" stage, rather than as a consistent marijuana to alcohol to tobacco sequence.

Progression to heavy alcohol use has usually been considered apart from the use of other substances. It would appear that the term "alcoholic" may be a misnomer insofar as it implies that only alcohol is the source of problems. According to the present results, marijuana and tobacco use are also intrinsically part of the problem. It is interesting that neither light use of tobacco nor light use of alcohol is a part of the Multiple Heavy Use sequence. This does not mean that those following this sequence never engaged in light tobacco or alcohol use; rather, it means that those following this sequence are no more likely than others to engage in these behaviors. However, those who have reached the final Multiple Heavy Use stage are quite likely to have engaged in light regular use of marijuana.

Robustness of Scales

The Tobacco Onset scale and the Multiple Heavy Use scale showed consistency in the cross-validation sample comparable to their consistency in the criterion sample, suggesting that these scales are probably not a result of capitalization on chance relationships in the data. However, we cannot be as sure about the

Moderate Alcohol Use scale, which showed an unacceptable degree of consistency in the cross-validation sample. The Tobacco Onset scale and the Multiple Heavy Use scales showed comparable consistency across the sexes, although there was a tendency for lower consistency for females in the Multiple Heavy Use scale. Kandel and Yamaguchi (1984) also showed a slight tendency for higher scale consistency in males. It seems unlikely that there would be a sex difference in data reliability; instead, the more likely explanation is simply that a sequential, cumulative pattern of Heavy Multiple Use is a better description of male behavior than it is of female behavior.

It is possible that the results reported here would not generalize to another age cohort. The present study was based on data from high school students. It may be that a longitudinal study based on younger adolescents, such as a junior high sample, would find different stage sequences. Or, it may be that stage sequences such as the ones found here do not become differentiated until the high school years.

Scale Consistency

Past research in the area of Guttman scales of substance use (Sinnett et al., 1972; Single et al., 1975; Hamburg et al., 1975; Huba et al., 1981; Donovan & Jessor, 1983; Yamaguchi & Kandel, 1984) have generally found very consistent scales. This may be because substance use follows a very consistent sequence. Alternatively, this consistency could be due to the use of cross-sectional or retrospective data in these studies rather than prospective longitudinal data.

It is difficult to compare the consistency of the results in the present study with those in past studies because of differences in methodology. However, there are some rough bases for comparison. CL is roughly comparable to the Coefficient of Scalability reported by Donovan and Jessor (1983) and to the

Proportion of Scale Types Not By Chance figures reported by Yamaguchi and Kandel (1984). In a series of analyses, Donvan and Jessor report that all their Coefficients of Scalability were above .6; in Yamaguchi and Kandel, the Proportion of Scale Types Not By Chance is .82 for men and .77 for women for the model the authors deem best-fitting and most parsimonious. In constrast, the CL for the most consistent scale in the present study is .48. Although a direct comparison cannot be made, it does seem likely that a higher overall level of consistency was achieved in Donovan and Jessor's cross-sectional data and in Kandel and Yamaguchi's retrospective data than was achieved in the present study. (There is no basis for comparison between the one previous prospective longitudinal study, Kandel and Faust (1975), and the present study; the methodology used by Kandel and Faust did not permit an overall assessment of consistency.) One explanation for this is measurement unreliability in the present data. However, data from the HASP study have been used successfully in other analyses (Hansen, Collins, Malotte, Johnson, & Fielding, 1985; Hansen, Collins, Johnson, & Graham, 1985; Johnson et al., 1986), making this explanation less likely. Another explanation is that stage sequences of substance use truly are less consistent than studies based on cross-sectional and retrospective data are capable of showing. Longitudinal measurement of substance use is subject to fewer of the response biases that can inflate the consistency of cross-sectional and retrospective measurement. When substance use in a cohort is followed longitudinally, a more accurate picture of the consistency of the sequence is obtained, and this picture shows that the stage sequences, though discernable, are less consistent than originally thought.

SUMMARY AND CONCLUSIONS

The present study has investigated the existence of stage sequences of drug use behavior in prospective longitudinal data. The study is unique in two respects. First, a new scaling model called the Longitudinal Guttman Simplex and some related methodology were used to determine whether 15 substance use items formed a cumulative sequential progression in an adolescent sample. Second, the data were collected four times over a three-year period, making this the longest longitudinal study to address the issue of stage sequences in substance use. The results indicate that while all 15 items together do not form a consistent progression, there are at least two subsets of items that do form consistent longitudinal Guttman scales. The scales are Tobacco Use Onset and Multiple Heavy Use. In addition, there was some evidence, although less compelling, for a Moderate Alcohol Use scale.

The results indicate that most substance use begins with trying beer or wine followed by trying liquor. Subjects who continue to deepen their substance use involvement then try cigarettes, then marijuana. At this point, after trying alcohol, cigarettes, and marijuana, subjects may continue on to regular tobacco use or heavy use of multiple substances. There is somewhat weaker evidence that some subjects go on to moderate alcohol use without ever trying tobacco or marijuana.

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Table 1

Items Used in LGS Analysis

Alcohol use items

TRIED BEER. Have you ever tried drinking beer? (no/yes)

TRIED WINE. Have you ever tried drinking wine? (no/yes)

TRIED LIQUOR. Have you ever tried drinking other alcoholic beverages? (no/yes)

ALCOHOL LAST 30 DAYS. Have you had any alcoholic beverages in the last 30 days? (no/yes)

How often do you drink alcoholic beverages?

Dichotomized as:

LIGHT ALCOHOL USE. never/any use

HEAVIER ALCOHOL USE. less than once a week/once a week or more

Tobacco use items

Have you ever tried smoking even part of a cigarette?

Dichotomized as:

TRIED TOBACCO. never/any

LIGHT TOBACCO USE. a few a month or less/more use

HEAVIER TOBACCO USE. a pack a week or less/more use

On the average how many cigarettes do you smoke a day?

Dichotomized as:

ANY REGULAR TOBACCO USE. none/any

How many cigarettes did you smoke yesterday?

Dichotomized as:

ANY TOBACCO YESTERDAY. none/any

Table 1 (Continued)

Marijuana use items

TRIED MARIJUANA. Have you ever tried smoking marijuana? (no/yes)

MARIJUANA LAST 30 DAYS. Have you smoked marijuana in the last 30 days? (no/yes)

How often do you smoke marijuana?

Dichotomized as:

LIGHT MARIJUANA USE. never/any

HEAVIER MARIJUANA USE. less than once a month/once a month or more

Table 2

Scale 1: Tobacco Use Onset

	Percent of Subjects in Each Stage			
	Winter 1981	Spring 1981	Spring 1982	Spring 1983
Tried beer	87	95	97	99
Tried wine	88	95	98	98
Tried liquor	80	93	97	99
Tried tobacco	67	77	81	84
Tried marijuana	56	68	76	78
Light tobacco use	16	22	25	28
Any regular tobacco use	11	18	20	17
Any tobacco yesterday	7	11	13	15
Heavier tobacco use	2	3	6	7

Table 3

Scale 2: Multiple Heavy Use

	Percent of Subjects in Each Stage			
	Winter 1981	Spring 1981	Spring 1982	Spring 1983
Tried beer	87	95	97	99
Tried wine	88	95	98	98
Tried liquor	80	93	97	99
Tried tobacco	67	77	81	84
Tried marijuana	56	68	76	78
Light marijuana use	42	53	56	56
Marijuana last 30 days	25	34	42	39
Heavier marijuana use	9	9	13	18
Heavier alcohol use	5	12	9	16
Heavier tobacco use	2	3	6	7

Table 4

Scale 3: Moderate Alcohol Use

	Percent of Subjects in Each Stage			
	Winter 1981	Spring 1981	Spring 1982	Spring 1983
Tried beer	87	95	97	99
Tried wine	88	95	98	98
Tried liquor	80	93	97	99
Alcohol last 30 days	59	67	78	84
Light alcohol use	35	51	64	66

Table 5

CL Values Reflecting Consistency of Longitudinal Guttman Scales Found in LGSCLUS Analysis

	Tobacco Use Onset	Multiple Heavy Use	Normal Alcohol Use
Total			
Criterion	.47	.38	.34
Cross-validation	.44	.34	.22
Boys			
Criterion	.48	.44	.40
Cross-validation	.42	.38	.22
Girls			
Criterion	.46	.33	.29
Cross-validation	.46	.30	.22